Dielectrics
Room: Exhibit Hall B2 - Session DI+EL-WeP

Poster Session

DI+EL-WeP2 Remote Plasma-assisted Cleaning, Oxidation and Oxidation/Nitridation of GaN for Low Defect Density GaN-SiO_2 Interfaces, ***C. Bae***, *G.B. Rayner*, *G. Lucovsky*, North Carolina State University

In previous studies, device quality Si-SiO_2 interfaces and dielectric bulk films (SiO_2) were prepared using a two-step process; i) remote plasma-assisted oxidation (RPAO) to form a superficially interfacial oxide (~0.6 nm) and ii) remote plasma enhanced chemical vapor deposition (RPECVD) to deposit the oxide film. The same approach has been applied to GaN-SiO_2 system. After a 300 °C remote N_2/He plasma treatment of the GaN surface, residual C and Cl were reduced below Auger electron spectroscopy (AES) detection, and the AES peak ratio of O KLL and N KLL was ~0.06 or ~0.1 monolayer of oxygen. RPAO of GaN surfaces using O_2, N_2O, and N_2O in N_2 source gases was investigated by AES and x-ray photoelectron spectroscopy (XPS) to determine the oxidation kinetics, chemical composition of the interfacial oxide and oxidation state of interfacial Ga. Without an RPAO step, subcutaneous oxidation of GaN takes place RPECVD deposition of SiO_2, and on-line AES indicate a ~0.6-0.8 nm subcutaneous oxide. Compared to single step SiO_2 deposition, significantly reduced defect state densities are obtained at the GaN-SiO_2 interface by independent control of GaN-GaO_x interface formation by RPAO and SiO_2 deposition by RPECVD.

DI+EL-WeP3 Screen Printing of PMN-PT Thick Films on the Pt-coated Silicon Wafers, ***B.M. Park***, *Y.-S. Seo*, *G.S. Lee*, University of Texas at Dallas

$Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (PMN-PT) is one of the widely studied relax ferroelectrics with excellent piezoelectric and electrostrictive properties. Single crystals, ceramics, and thin films of PMN-PT have been investigated for various applications such as actuators, transducers, and etc. However, there have not been enough studies for thick film fabrication of PMN-PT and its applications. For a promising application of the mechanical actuating of PMN-PT in the silicon-based integrated processing, an easy and low-cost technique for the thick film fabrication should be developed. The screen printing is one of the well known techniques to make thick films easily. Thus, in this study, we investigated a screen printing of PMN-PT thick films for electronic applications. The two kinds of pastes with different ratios between 0.9PMN-0.1PT ceramic powders and vehicle such as 6:4 and 7:3 were used. Thick films were printed through 200 mesh or 325 mesh screens on the platinum coated silicon wafers. The printed films were burn out at 600°C then heat treated at various conditions for the sintering of ceramic powders. The films were characterized by using optical and scanning electron microscopes and X-ray diffraction. As the results, the uniform thick films of PMN-PT could be made and the thickness of a singly printed film was about 10µm after heat treatment. When the printed films were heat treated at higher temperatures and for longer times, it caused to form the pyrochlore phase. The pure perovskite PMN-PT film could be obtained when it was heat treated at 800°C for 1hour or less. To prevent the pyrochlore phase from being formed, the additions of small excess amount of PbO and MgO were studied also. The addition of excess PbO or MgO can be expected to retard the pyrochlore formation. Some electrical properties of these screen printed films will be discussed also here.

DI+EL-WeP4 Influence of Impurities on Attenuation of Acoustic Waves in $LiNbO_3$ Crystals, *F.R. Akhmedzhanov*, ***M.M. Akhmedjanova***, Samarkand State University, Uzbekistan

In present work the attenuation of longitudinal and transverse acoustic waves in pure LiNbO3 and Mg, Zn, Cu and Cr doped LiNbO3 crystals have been investigated in detail. The weight concentration of above-mentioned impurities in investigated samples was consisted 0.01-0.02 percents. The measurements of attenuation coefficient carried out by Bragg light scattering method at the temperatures 295 K and 480 K. Piezoelectric transducers of Lithium Niobate of appropriate cuts are used in order to excite the longitudinal and the transverse acoustic waves with the frequencies of 0.3-1.8 GHz. The values of attenuation coefficients were determined from the measurements of the dependence of the scattered light intensity from the distance to the piezotransducer along the direction of the acoustic wave propagation. The obtained values of the scattered light intensities have been used to calculate the quantity and frequency dependence of the attenuation coefficient of the acoustic wave. The velocities of all the investigated waves were with sufficient accuracy determined from the experimental data simultaneously. The results of measurements have shown that in crystals with impurities are observed the changes in the attenuation of acoustic waves. Also have shown that the impurity of Cr causes increase of the attenuation of longitudinal waves on 20-50% but at the same time decreases the attenuation of transverse waves almost in two times. At the same time impurities of Cu, Zn, Mg reduce the decrease of attenuation the longitudinal waves in 1,5-2 times and insignificantly increase of the attenuation of the transverse waves. The obtained results are interpreted in framework of various mechanisms of attenuation including the electron-phonon, Akhiezer and Landau-Khalatnikov mechanisms. The influence of dielectric losses on the attenuation of piezoactive acoustic waves in LiNbO3 crystals is also discussed.

DI+EL-WeP5 Study of Molecularly Templated Nanoporous Silica Dielectrics with an a-SiC:H Etch Stop Layer Deposited by High Density Plasma Chemical Vapor Deposition, *F.M. Pan*, ***B.W. Wu***, *A.T. Cho*, *T.G. Tsai*, *K.C. Tsai*, National Nano Device Laboratories, Taiwan, R.O.C., *C.M. Yang*, *K.J. Chao*, National Tsinghau University, Taiwan, R.O.C.

α-SiC:H thin films were deposited on nanoporous silica thin films as the etch stop layer by high-density plasma chemical vapor deposition (HDP-CVD) using trimethylsilane (3MS) as the precursor. The α-SiC:H thin film can effectively improve hydrophobicity of the nanoporous film during HDP-CVD deposition, and, therefore, improve the dielectric property of the nanoporous dielectric layer. Electron spectroscopy for chemical analysis (ESCA) and Auger electron spectroscopy (AES) depth profiles reveal that the methyl groups uniformly distribute in the nanoporous film after the α-SiC:H film deposition. After the α-SiC:H film deposition and hydrogen plasma treatment, the effective dielectric constant of the α-SiC:H/silica film can be as low as 1.65, and slowly rises to 1.98 after a 25 day storage in the cleanroom ambient. This study shows that hydrophobicity modification of the nanoporous silica film and the etch stop layer deposition can be completed at the same time during the α-SiC:H depostion. Moreover, calcination of the surfactant templated nanoporous film can be accomplished in the same HDP-CVD before the etch stop layer deposition. This obviously simplifies the integration steps of nanoporous silica materials in the dual-damascene interconnect technology.

DI+EL-WeP6 Degradation and Modification of Gate Dielectric in MOS Structures by High-field Multilevel Current Stress, ***G.G. Bondarenko***, Moscow Institute of Electronics and Mathematics, Russia, *V.V. Andreev*, *A.A. Stolyarov*, *V.E. Drach*, Bauman Moscow State Technical University, Russia

A new technique for the modification and the degradation analysis of gate dielectric in the MOS structures by means of high-field tunnel electron injection is proposed. It was found out that the injection treatment of the MOS structures by multilevel current stress allows to increase the charge-to-breakdown. The technique is proposed to be used for investigation of the gate dielectric degradation in the MOS structures during and after high-field stress. The proposed technique differs from an ordinary constant current stress technique in the additional measuring level of current, thus providing the possible to estimate the dielectric charge change. The additional measuring level of injection current allows to decrease significantly the error of positive charge density measurement in the dielectric. Disregarding of positive charge trapping during the initial part of injection of electrons into dielectric while stress mode is being established causes the error above. The technique allows right after high-field injection without sample re-switching to investigate both the generation and the relaxation of positive charge, created by injected electrons into MOS structure gate dielectric in wide range of electric fields. Using the technique proposed, the injection degradation of the MOS structures with thermal SiO_2 film was studied. Furthermore, the possibility of modifying the film above to increase the injection reliability was shown.

DI+EL-WeP7 Improvement of $(Ba,Sr)TiO_3$ Dielectric Properties by in-situ Formation of IrO_2 on Ir Electrodes, ***C.H. Lai***, *Y.C. Wu*, *W.C. Chen*, National Tsing Hua University, Taiwan, *S. Ma*, Applied Materials

The $(Ba,Sr)TiO_3$ (BST) thin films grown on Ir bottom electrodes have showed high dielectric constants and low leakage current density, which are generally attributed to the formation of IrO_2 at the BST/Ir interface. The IrO_2 can decrease the accumulation of the oxygen vacancies, and typically was formed during the post-annealing process. In this work, we use high working pressure (47 mtorr) during rf sputtering deposition to enhance the in-situ formation of IrO_2 without post-annealing. We verified that oxygen plasma bombardment on the Ir surface during the deposition of BST films was the dominant mechanism for IrO_2 formation under the condition of high working pressure. The as-deposited BST films of 100 nm grown at 500 C show a dielectric constant as large as 550 (at 10 kHz); however, the leakage current is relatively large (10^{-4} A/cm^2 at 200 kV/cm). The large leakage current resulted from rough interface due to formation of thick IrO_2. To reduce leakage current, the double-layer technology was used, in which a thin BST film (5 nm) was deposited with pure Ar, and followed by deposition of a thick film (95 nm) with mixture gas (Ar/O_2). The thin BST layer can significantly reduce the roughness of IrO_2, resulting in lower leakage current (10^{-6} A/cm^2); however, since this thin BST layer is oxygen-deficient, the dielectric constant is slightly reduced. When the total BST thickness decreased, the reduction of dielectric constant becomes significant in the double-layer structure. For 30 nm BST films, we applied a dc substrate bias (-100V) during BST deposition to manipulate the film structure. The substrate bias significantly increases the film density and grain size, and at the same time reduces the roughness. Consequently, a large dielectric constant (220 at 10KHz) and a quite low leakage current (10^{-9} A/cm^2) were obtained in 30 nm BST films.

DI+EL-WeP9 Medium to High Vacuum Metal Organic Chemical Vapor Deposition of Al_2O_3, ***Z. Song****, R.D. Geil, V. Parwar, D.W. Crunkleton, C.A. Hales, B.R. Rogers*, Vanderbilt University

Al_2O_3 is one of the most promising medium-k gate dielectric materials to replace SiO_2 in future high performance integrated circuits. Because of good interfacial properties of the Al_2O_3/Si system, the 2001 update of the ITRS indicates the possibility of using Al_2O_3 as an interfacial layer between silicon and high-k dielectrics that tend to form interfacial SiO_2 or silicate layers. This presentation reports results of our work on the deposition of Al_2O_3 onto cleaned silicon substrates. We have performed two types of deposition experiments. First, Al_2O_3 films were deposited on p-type Si(100) substrates by metal organic chemical vapor deposition from aluminum tri-s-butoxide. We used a temperature range of 300 - 450 °C and a pressure range in the medium to high vacuum regimes. Second, silicon surfaces were briefly exposed to the precursor gas at low temperatures in our one-of-a kind UHV-CVD system. The gas was then pumped out and the silicon substrate was heated to a preset temperature. The gases released during temperature ramping were analyzed by in-situ quadruple mass spectroscopy (QMS). The properties of the films were characterized by Spectroscopic Ellipsometry (SE), Time of Flight Medium Energy Back Scattering (ToF-MEBS), RBS, XPS, XRD and ATR FT-IR.

DI+EL-WeP10 N Composition and Chemical State Profiling in Thermally and Plasma Nitridated Silicon Oxide Films, ***Y.S. Chung***, Samsung Advanced Institute of Technology, Korea, *H.S. Chang, D.W. Moon*, Korea Institute of Standards and Science

The composition and chemical state of N in thermally and plasma nitridated silicon oxide films were depth profiled by X-ray Photoelectron Spectroscop (XPS) using a chemical etching method with HF. The nitrogen profile of thermally nitridated film differs from plasma nitridated one. Nitrogen is rich at surface in plasma nitridated oxide films, while N is rich at interface in thermally nitridated film. The N depth profiles from XPS were compared with those from medium energy ion scattering spectroscopy in a good agreement. The N 1s core level of plasma nitridated oxide shows a main species with N?Si3 bonding and small amounts of defect nitrogens due to plasma treatment. The change of chemical composition with annealing to cure these defect also will be discussed.

DI+EL-WeP11 Study on Damage Recovery of Etched $(Ba_{0.6},Sr_{0.4})TiO_3$ Thin Films in Ar/CF_4 Plasma, ***P.S. Kang****, D.P. Kim, K.T. Kim, C.I. Kim*, Chung-Ang University, Korea, *T.H. Kim,* YIT, Korea, *S.J. Lee*, ETRI, Korea

In this study, $(Ba_{0.6},Sr_{0.4})TiO_3$ (BST) thin films on $Pt/Ti/SiO_2/Si$ substrates were deposited by a sol-gel method and the inductively coupled plasma (ICP) etching behavior of BST thin films had been investigated by a function of Ar/CF_4 gas mixing ratio. We also investigated the influence of etching damage in BST films during the ICP process. For analysis of the Ar/CF_4 plasma-induced damage in the Pt/BST/Pt capacitor, measurements of leakage current density and dielectric constant was carried out at different substrate bias voltage, ICP power and gas mixing ratio. The physical damage and structure of etched BST thin films were investigated by atomic force microscopy (AFM) and x-ray diffraction (XRD). The existence of contamination on the surface of the etched BST was measured using an x-ray photoelectron spectroscopy (XPS) analysis. Fluorine atoms definitely disappeared after O_2 annealing at 700°C. From the electrical property and structure analysis, the reduction and recover of etching damage by re-annealing was effective in the additive O_2 into Ar/CF_4 rather than additive O_2 into Ar/Cl_2 plasma.

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DI+EL-WeP12 Etching Characteristics of $(Pb,Sr)TiO_3$ Thin Films Using Cl_2/Ar Inductively Coupled Plasma, ***G.H. Kim****, D.P. Kim, K.T. Kim, C.I. Kim*, Chung-Ang University, Korea

Recently, ferroelectric thin films have received great attention for the application to high density memory devices. Among the various ferroelectric films, the BST thin film was noticed as the most promising material due to its high dielectric constant and paraelectricity at normal operating temperature. Although BST possesses a satisfactorily high dielectric constant, it was known that a post heat treatment at a high temperature was essential to obtain good electrical property. The heat treatment at high temperature can cause deleterious effects on an electrode, barrier metal, and contact plug. Strontium titanate ($SrTiO_3$) is one of the few titanates which is cubic at room temperature. But, the dielectric constant is lower than BST. The addition of lead into strontium titanate makes its dielectric constant(ε_r=1377) higher and the temperature of crystallization lower. Therefore, PST thin film can be a promising material due to its high dielectric constant and paraelectricity at normal operating temperature. However, there is no report on the characteristics and mechanism of PST thin films during etching process. In this study, Inductively coupled plasma etching system was used for etching PST because of its high plasma density, low process pressure and easy control bias power. The etching characteristics of PST thin films were investigated in terms of etch rates and selectivity as a function of gas mixing ratio, rf power, dc bias voltage and chamber pressure. The Cl_2/Ar plasmas were characterized by optical emission spectroscopy and Langmuir probe analysis. The chemical states on the etched surface were investigated with x-ray photoelectron spectroscopy and secondary ion mass spectrometry. Scanning electron microscopy was used to investigate the etching profile.

Acknowledgement:This work was supported by Korea Research Foundation Grant (KRF-2001-042-E00042).

DI+EL-WeP13 Etching Characteristics of $Bi_{4-x}Eu_xTi_3O_{12}$ Thin Films Using Inductively Coupled Plasma, *K.T. Lim, D.P. Kim, K.T. Kim,* ***C.I. Kim***, Chung-Ang University, Korea

In recent years, some Bi-layered perovskite oxide such as $SrBi_2Ta_2O_9$ (SBT) and $Bi_{4-x}La_xTi_3O_{12}$ (BLT) have been intensively studied for use in FRAMs because of its low leakage current, low coercive field, and fatigue-free with simple Pt electrode. The fatigue-free behavior of SBT and BLT thin film was due to the charge compensating effect of Bi_2O_2 layers resulting in the reduction of space charge and from domain wall unpinning that happens at least as rapidly as domain pinning. However, SBT and BLT thin films have a disadvantage of low remanent polarization for the high-density integration of FRAMs. From the viewpoint of the general formula of Aurivillius compounds, radii of Europium ion (0.95 Å), similar to Bi ion (0.93 Å) in the $Bi_4Ti_3O_{12}$(BIT), occupies the A site in the perovskite unit BIT. The europium-substituted BIT(BET) thin films resulted in a large 2Pr, whose value (60.99μmC/cm^2) is much larger than that of Sm-modified BIT thin film (2Pr = BSmT: 49μmC/cm^2) and BLT thin film (2Pr = 27μmC/cm^2) at an applied voltage of 10V. For this advantage, BET thin films have emerged as new ferroelectric materials. However, there is no report on etching BET thin films. Inductively coupled plasma source was used for etching BET because of its high plasma density, low process pressure and easy control bias power. BET thin films were etched with using CF_4/Ar plasma. The experiments were carried out with measuring etch rates and selectivities as a function of gas mixing ratio, rf power, dc bias voltage. The chemical states on the etched surface were investigated with x-ray photoelectron spectroscopy (XPS) and secondary ion mass spectrometry (SIMS). Atomic force microscopy (AFM) and scanning electron microscopy (SEM) were used to investigate the surface morphology of BET thin films exposed in plasma and etching profile.

DI+EL-WeP14 Etching Characteristics of $YMnO_3$ Thin Films in Cl Based Inductively Coupled Plasma, ***J.H. Park****, D.P. Kim, K.T. Kim, C.I. Kim, E.G. Chang*, Chung-Ang University, Korea

$YMnO_3$ thin films are excellent dielectric materials for high integrated FRAM because $YMnO_3$ have a relatively low permittivity (ε_r=20) and do not include volatile materials such as Pb and Bi which easy diffuse into the Si substrate and lead to point defects. To apply the $YMnO_3$ thin films on the highly integrated FRAMs, high-density plasma systems should utilized because it provides high degree of anisotropy and good selectivity. In this study, we etched $YMnO_3$ thin films in Cl based inductively coupled plasma (ICP). Etching characteristics of $YMnO_3$ thin films were investigated in terms of etch rate and selectivity as a function of gas mixing ratio, RF power, and substrate temperature. The diagnostics of the plasma were estimated using optical emission spectroscopy (OES). To investigate etching mechanisms of $YMnO_3$ thin film, chemical reactions on the etched surface of $YMnO_3$ thin films were investigated by X-ray photoelectron spectroscopy (XPS) and secondary ion mass spectroscopy (SIMS). Etching profile was investigated by scanning electron microscopy (SEM).

DI+EL-WeP15 The Effect of Cr Doping on the Microstructural and Dielectric Properties of (Ba_{1-x},Sr_x)TiO_3 Thin Films for Tunable Microwave Device Applications, ***C.I. Lee***, Ansan College of Technology, Korea, *K.T. Kim, C.I. Kim, D.H. Kang*, Chung-Ang University, Korea

(Ba_{1-x}, Sr_x)TiO_3 (BST) thin film is a very attractive material for the tunable microwave device applications such as electronically tunable mixers, delay lines, filters and phase shifters. We have investigated the structural, compositional and dielectric properties of BST thin film as a function of Cr dopant concentration from 0 to 15 mol% and analyzed using X-ray diffraction (XRD), atomic force microscopy (AFM) and scanning electron microscopy (SEM). The dielectric constant of the 300 nm Cr-doped BST thin film decreased as the Cr concentration increased. The loss tangent of 15% Cr doped BST thin film was higher than that of the pure film, but the 1~10 mol% Cr doped thin film was lower than that of the undoped BST thin film.

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DI+EL-WeP16 Cyclic-CVD of Strontium Tantalate for Alterantive Gate Dielectric Applications, *H.S. Choi*, ***Y.M. Jang***, *M.J. Kang, I.H. Choi*, Korea University

As gate oxide thickness in SiO_2-based MOS device decreases, new high-k dielectric materials are demanded to substitute for silicon dioxide. In this presentation, we will discuss our work on developing strontium tantalate for use as alternative gate dielectrics. We have grown strontium tantalate thin films on p-type Si substrate by cyclic chemical vapor deposition technique using $Sr[Ta(OC_2H_5)_5(OC_2H_4OCH_3)]_2$ as precursor. Our studies have included substrate temperatures between 250 and 400°C and post annealing temperatures 600 and 800°C. We have studied the surface and interface image, the structural properties and film compositions by Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD) and Rutherford Backscattering Spectrometry (RBS). Also we have investigated the applicability to MOS device through the capacitance voltage (C-V) measurement and leakage current measurement.

DI+EL-WeP17 Surface Preparation of Si (100) Substrates Prior to Deposition of High K Dielectrics, ***V. Pawar***, *Z. Song, D.W. Crunkleton, B.R. Rogers*, Vanderbilt University

We have investigated different fluoride based reagents for etching of native oxide on silicon surfaces prior to chemical vapor deposition of high K dielectrics. We have also investigated different cleaning agents (water and organic based) to see the effect on the native oxide growth and surface cleanliness. The native oxide growth was monitored by spectroscopic ellipsometry and x ray photoelectron spectroscopy. We have shown that time logarithmic model can be used to model the data and useful information about the characteristic time (incubation time) can be obtained for different treatments.

DI+EL-WeP18 Comparison of Reactive Sputtered Oxide Films from Zr and Hf Metal Targets with Poly-Si or Poly-SiGe Gate, ***J.-H. Yoo***, Yonsei University, Korea, *S.-W. Nam*, Samsung Electronics Co., Ltd., Korea, *S. Nam, D.-H. Ko*, Yonsei University, Korea

As CMOS devices are being continuously scaled down, gate oxides with EOT < 15Ã… will be required. Key process issues in conventional SiO_2 scaling are with boron penetration, gate leakage for very thin gate oxides and depletion effects in the polysilicon electrodes. Therefore, dielectric materials with higher dielectric constant than SiO_2, possibly large band-gap, low interface state density, and good thermal stability have drawn a lot of attention as alternative gate dielectric materials. Recently, ZrO_2, HfO_2 and their silicates have been considered as promising alternative materials due to their high dielectric constant and good thermal stability with Si substrates. We investigated the microstructures and electrical properties of reactive sputtered ZrO_2 films and HfO_2 films on Si (100) substrate. And the thermal stabilities and compatibilities between the films with poly-Si gate electrode were compared. The films as a gate dielectric were deposited by reactive dc magnetron sputtering, followed by thermal annealing in N_2 gas ambient using furnace and subsequently the microstructures of the films were investigated by Ellipsometry, XRD, AFM, TEM and XPS. The interfaces with poly-Si or Si substrate were carefully observed by HR-TEM, XPS/AES and SIMS with annealing temperature. Also, the properties of the films with poly-SiGe as alternative gate electrode were investigated. The electrical properties were assessed and compared by C-V and I-V measurements of Metal-Oxide-Semiconductor capacitor structure.

DI+EL-WeP19 Mechanical and Optical Properties of Low Dielectric Constant Silicon Containing Fluorocarbon Films by Plasma Enhanced Chemical Vapor Deposition, ***Y.Y. Jin***, Louisiana State University, *G.S. Lee*, The University of Texas at Dallas

Silicon containing fluorocarbon (SiCF) film for use as low-k interlayer dielectrics (ILD) has been investigated on mechanical and optical properties. The preparation of SiCF films is carried out by plasma enhanced chemical vapor deposition (PECVD) using precursors 5% disilan in helium (5%Si_2H_6/He) and tetrabluorocarbon (CF_4). Hardness and residual stress in the films subsequently measured using an atomic force microscopy (AFM) and the curvature method via Stoney's equation, respectively. The SiCF film samples were deposited on quartz plates to investigate the characteristics of optical transmission and optical energy gap. The optical transmission data were obtained in the wavelength range of 200 nm to 800 nm by the NIR-UV-VIS spectrophotometer at room temperature. The optical energy gaps of the films are calculated from a plot of Tauc extrapolations.

DI+EL-WeP20 Effect of Low Pressure Annealing for Low Temperature Crystallization of $SrBi_2Ta_2O_9$ Ferroelectric Thin Films, *H.S. Choi*, ***K. Lee***, *G.S. Lim*, Korea University, *Y.T. Kim, S.I. Kim*, Korea Institute of Science and Technology, *I.H. Choi*, Korea University

A new low pressure annealing method for low temperature crystallization of $SrBi_2Ta_2O_9$ thin films is proposed. SBT films were prepared on IrO_2 bottom electrode by metalorganic decomposition (MOD) method and annealed under low oxygen pressure by a modified rapid thermal annealing process. Under an oxygen pressure as high as 30 torr, the crystallization temperature inducing the ferroelectric SBT phase can be lowered to 650°C. Those films processed at 650°C showed satisfactory ferroelectric properties, that is, the remanent polarization (P_r) and the coercive electric field (E_c) were 5.68 $\mu C/cm^2$ and 61 kV/cm at an applied voltage of 5 V, respectively. The films also showed fatigue-free characteristics: no fatigue was observed up to about 10^{10} switching cycles.

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